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Canadian Science Advisory Secretariat
Pacific Region | Science Response 2015/007

SUFFICIENCY REVIEW OF THE INFORMATION ON EFFECTS OF UNDERWATER NOISE AND THE POTENTIAL FOR SHIP STRIKES FROM MARINE SHIPPING ON MARINE MAMMALS IN THE FACILITIES APPLICATION FOR THE TRANS MOUNTAIN EXPANSION PROJECT

Context

Trans Mountain Pipeline ULC (Trans Mountain) is proposing an expansion of its current 1,150 km pipeline system between Strathcona County, AB and Burnaby, BC (the Trans Mountain Expansion Project, hereafter 'the Project'). On December 16, 2013, Trans Mountain filed a Facilities Application for the Project with the National Energy Board (NEB), pursuant to the *National Energy Board Act*, and on April 2, 2014, the NEB determined that the Application was complete, thereby commencing a 15-month environmental assessment review under the *Canadian Environmental Assessment Act, 2012*.

As part of the application, NEB included a requirement that the Proponent (Trans Mountain) consider the environmental and socio-economic effects of marine shipping activities that would result from the proposed Project, including the potential effects of accidents or malfunctions that may occur; this was delivered by way of issue # 5 in the NEB's List of Issues to be considered at the Hearings (NEB 2013a) and was provided to Trans Mountain in a letter outlining its filing requirements with respect to this topic (NEB 2013b).

Through scoping, the Proponent has identified underwater noise from Project-related marine vessel traffic as a potential source of sensory disturbance to marine mammals. They consider ship strikes to marine mammals as a potential accident or malfunction that could occur between marine mammals and Project-related traffic. The assessment of potential effects of the increase in Project-related marine vessel traffic is centered on the established in-bound and out-bound marine shipping lanes in the Marine Regional Study Area (Marine RSA) (Figure 1).

An increase in marine vessel traffic associated with the Project has the potential to result in sensory disturbance to marine mammals from underwater noise, ranging from auditory injury to behavioural disturbance, and an increased risk of injury and mortality associated with mammal-vessel strikes. Disturbance responses associated with increased Project-related vessel traffic could range from temporary displacement, to reduced foraging efficiency, to disruption of mating and social behaviours.

As an Intervenor in the environmental assessment hearing process for the Trans Mountain Expansion Project, Fisheries and Oceans Canada (DFO) will be asked to present evidence at Public Hearings in October 2015 in relation to its expertise on the effects of the Project on fish and fish habitat and aquatic species at risk, the efficacy and adequacy of mitigation and offsetting measures, monitoring and follow-up programs proposed by the Proponent, and the conclusions reached in Facilities Application for the Project.

DFO's Pacific Region Fisheries Protection Program (FPP) is responsible for the review of the marine terminal, and shipping components of the proposed Project. FPP is requesting DFO

Science Branch provide an evaluation of the adequacy of the Proponent's Facilities Application and supplemental information with respect to risks and potential consequences of underwater noise and marine vessel strikes that may result from Project-related marine shipping on indicator marine mammals in the Marine RSA. FPP is requesting Science advice to assist in the development of DFO's evidence submission to the National Energy Board for the Trans Mountain Project. DFO Science Branch has been asked to focus its review on direct effects on marine mammals, not including potential effects of underwater noise on prey species, such as fish.

The objective of this CSAS Science Response (SR) is to review information provided by the Proponent in the December 2013 Facilities Application, and in supplemental filings with the NEB, and to provide a Science Response to answer the following questions:

1. Is the information provided by the Proponent in the Project Application sufficient for DFO Science to assess underwater noise and marine vessel strikes, and their potential impacts on the marine mammal indicator species identified in the Project Application?
2. Are the methods used to assess the potential effects of underwater noise and marine vessel strikes on the marine mammal indicator species appropriate and executed properly?

This Science Response Report results from the Science Response Process of December 5, 2014 on the Sufficiency review of the information on effects of Marine Shipping on Marine Mammals in the Facilities Application for the Trans Mountain Expansion Project.

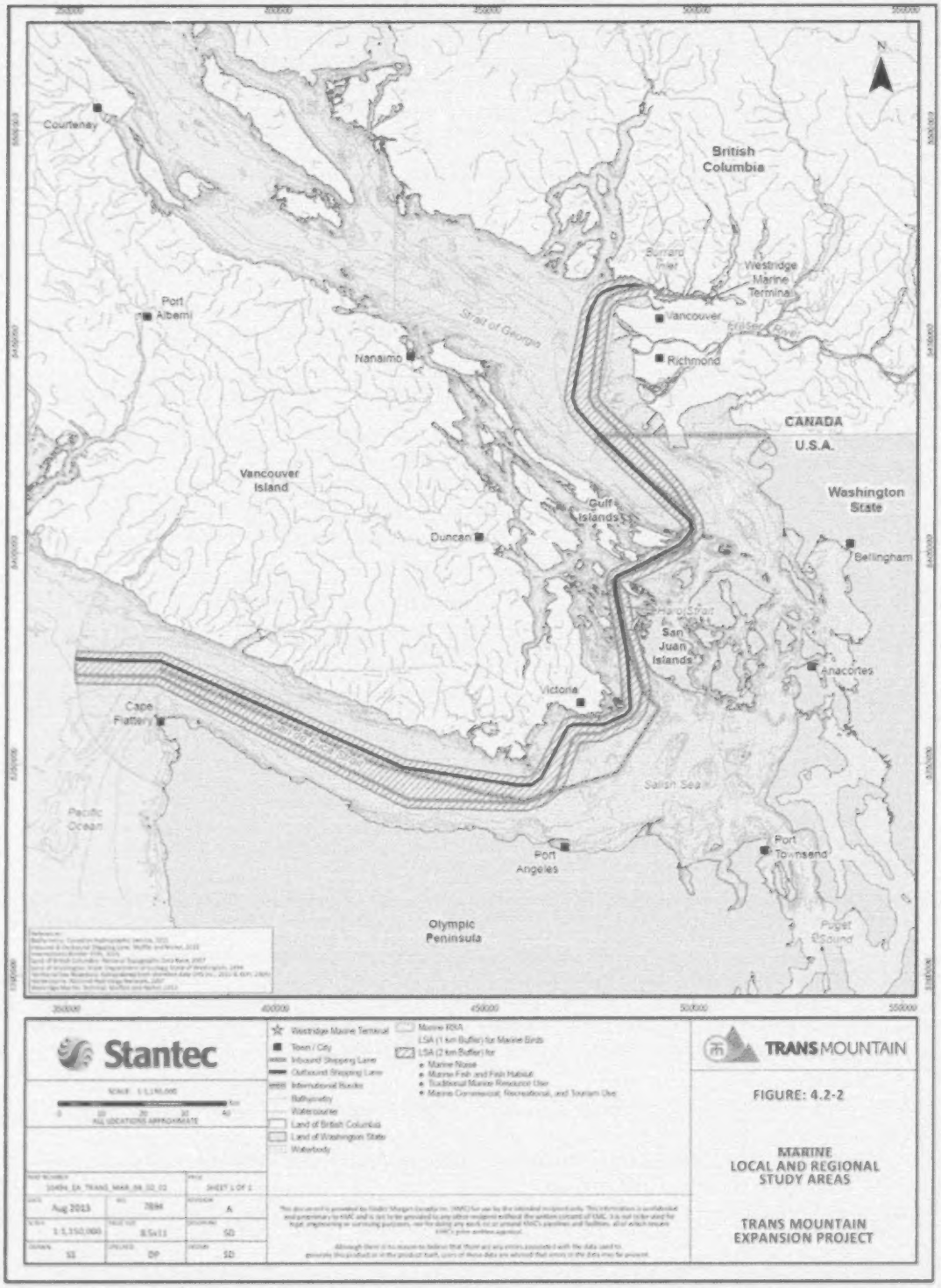

Figure 1. The Marine Regional Study Area (RSA). (from Trans Mountain Pipeline ULC, 2013. Trans Mountain Expansion Project – An Application Pursuant to Section 52 of the National Energy Board Act, Volume 8A - Marine Transportation).

Background

The existing Trans Mountain pipeline (TMPL) system commenced operation in 1953, and transports a range of crude oil and petroleum products from Western Canada to locations in central and southwestern British Columbia (BC), Washington State, and offshore. The proposed Project would create a twinned pipeline, increasing the capacity of the system from approximately 300,000 barrels per day to 890,000 barrels per day. Key Project components include 994 km of new pipeline, reactivation of 193 km of existing pipeline, 12 new pump stations and expansion of existing pump stations and storage tanks, and the addition of three new vessel berths at the Westridge Marine Terminal in Burnaby, BC.

For this particular Science Branch review, the marine vessel traffic that will transport the petroleum products is of relevance. The proposed expansion is forecasted to increase marine vessel traffic from 5 tankers per month calling at the Westridge Marine Terminal to approximately 34 tankers per month (i.e., an additional 720 tanker transits each year). At present the maximum size of petroleum tankers that call at the Westridge Terminal are Aframax class which have an average cargo carrying capacity of 750,000 barrels. The maximum size of tankers is not expected to change as part of the Project. These vessels will transit the Marine Regional Study Area (Marine RSA) using existing in-bound and out-bound shipping lanes (Figure 1). It will take each Project-related Marine vessel approximately 12 hours to complete one transit of the Marine RSA, and on average, there will be two transits every 24 hours. This will be in addition to existing traffic in the shipping lanes and other traffic in the Marine RSA (Figure 1).

There are 22 species of marine mammals identified by the Proponent as being present in the Marine RSA. The most commonly observed species of toothed whales in the Marine RSA include Killer Whales (*Orcinus orca*), Harbour Porpoises (*Phocoena phocoena*), Dall's Porpoises (*Phocoenoides dalli*), and Pacific White-sided Dolphins (*Lagenorhynchus obliquidens*). Critical habitat for the Southern Resident Killer Whale population listed as endangered under the *Species at Risk Act* (SARA) overlaps almost entirely with the Marine RSA (Figure 2). The Humpback Whale (*Megaptera novaeangliae*), which is listed as threatened under the *SARA*, is the most commonly observed baleen whale, and the western-most portion of the Marine RSA overlaps proposed Humpback Whale critical habitat (Figure 2). Other baleen whales including the Minke Whale (*Balaenoptera acutorostrata*) and Grey Whale (*Eschrichtius robustus*), as well as the occasional Fin Whale (*Balaenoptera physalus*) are also observed. The Harbour Seal (*Phoca vitulina*), and Steller (*Eumetopias jubatus*) and California (*Zalophus californianus*) Sea Lions are the most common pinnipeds observed in the Marine RSA, as well as the occasional Northern Elephant Seal (*Mirounga angustirostris*). Sea Otters (*Enhydra lutris*) are also occasionally sighted. The Proponent's assessment of potential effects is on three marine mammal species identified as indicators of toothed whales, baleen whales and pinnipeds in the Marine RSA; respectively these are Southern Resident Killer Whales, Humpback Whales, and Steller Sea Lions.

The increase in marine vessel traffic associated with the proposed Project has the potential to result in sensory disturbance to marine mammals from underwater noise, and an increased risk of injury and mortality associated with mammal-vessel strikes. This Science Response examines whether the Proponent has provided sufficient information and conducted appropriate analyses from which to draw conclusions on the effects of increased marine vessel traffic on selected marine mammal indicator species.

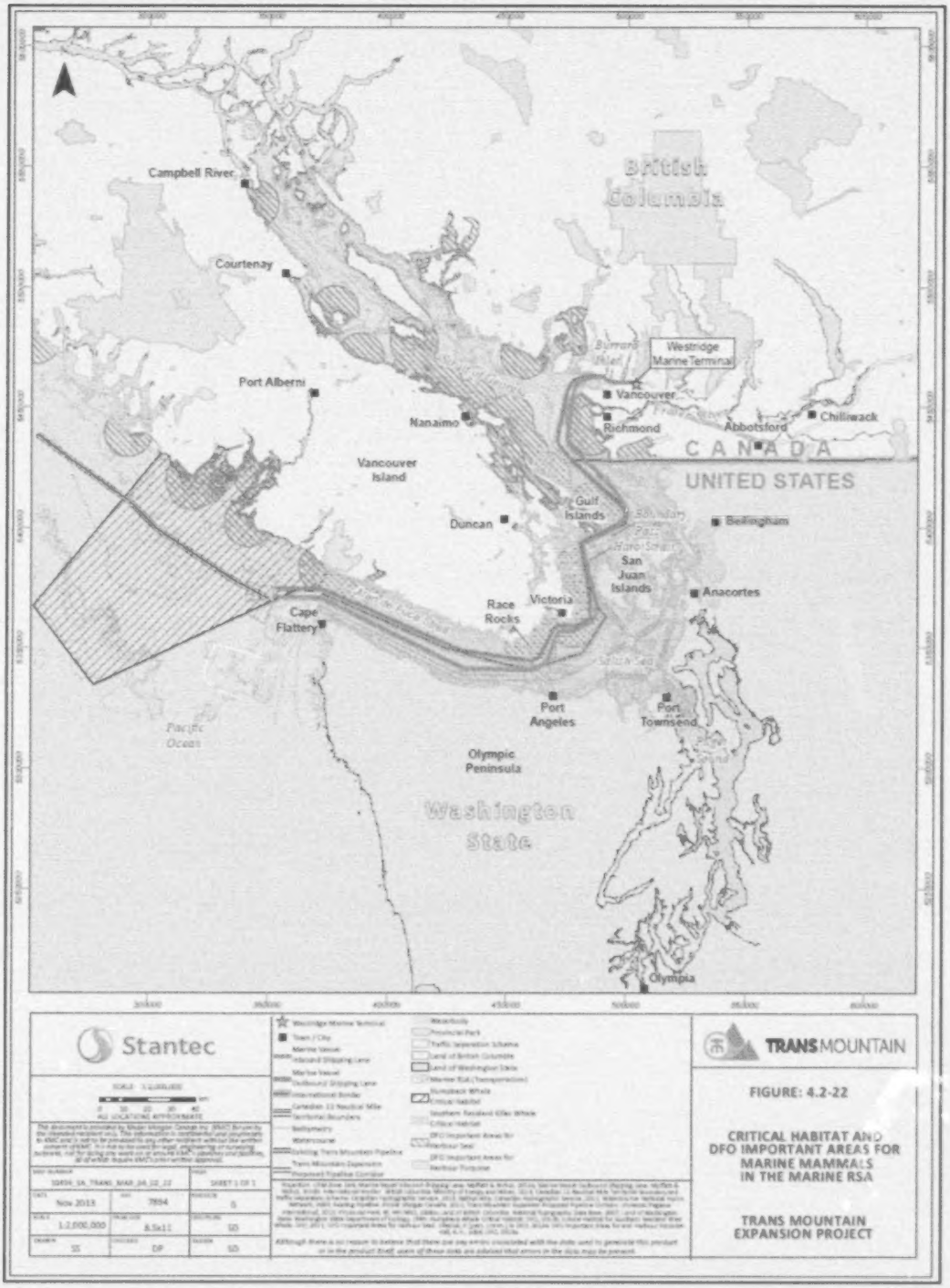

Figure 2. Critical Habitat for Southern Resident Killer Whales, proposed Critical Habitat for Humpback Whales and other important areas for marine mammals in the Marine RSA. (from Trans Mountain Pipeline ULC, 2013. Trans Mountain Expansion Project – An Application Pursuant to Section 52 of the National Energy Board Act, Volume 8A - Marine Transportation).

Analysis and Response

Science Branch responses to the two sufficiency questions posed by DFO FPP above (see Context) are detailed below.

To prepare this response, the following documents from the Proponent were reviewed:

1. Trans Mountain Pipeline ULC. 2013. Trans Mountain Expansion Project – An Application Pursuant to Section 52 of the National Energy Board Act, Volume 8A - Marine Transportation. Submitted to the Secretary of The National Energy Board.
2. JASCO Applied Sciences. 2014. Supplemental Underwater Noise Modelling for Trans Mountain Expansion Project. Prepared for Stantec Ltd. Document 00542, Version 5.0: 51 p.
3. Trans Mountain Pipeline ULC. 2014. Trans Mountain Response to The National Energy Board Information Request No. 1. NEB Hearing Order OH-001-2014. Trans Mountain Document Number: A3W9H8. Submitted to the Secretary of The National Energy Board.
4. Trans Mountain Pipeline ULC. 2014. Trans Mountain Response to Information Request from Val Veirs. NEB Hearing Order OH-001-2014. Trans Mountain Document Number: A3X6V7. Submitted to the Secretary of The National Energy Board.
5. Moffat & Nichol. 2013. TERMPOL 3.2 – Origin, Destination & Marine Traffic Volume Survey. Trans Mountain Expansion Project. Prepared for Trans Mountain. Trans Mountain Document Number: A3S4R7 and A3S4R8. Submitted to the Secretary of The National Energy Board.
6. Trans Mountain Pipeline ULC. 2014. Trans Mountain Response to The National Energy Board Information Request No. 2. NEB Hearing Order OH-001-2014. Trans Mountain Document Number: A3Z4T9. Submitted to the Secretary of The National Energy Board.

Information Sufficiency: Is the information provided by the Proponent in the Project Application sufficient for DFO Science to assess underwater noise and marine vessel strikes and their potential impacts on the marine mammal indicator species identified in the Project Application?

The Proponent has provided an extensive review of literature on underwater noise and the potential effects on marine mammals and has referenced publications that evaluate ship strike risk to whales in shipping lanes. However the Proponent's assessment of effects lacks a standardized structured quantitative or qualitative framework with which to adequately evaluate the impacts of underwater noise and of ship strikes and their potential significance. There are methods available in the literature (e.g., Lawson and Lesage 2012) that provide a framework to systematically identify, describe, and evaluate activities and their potential effects on ecosystems or their components. The inclusion of an appropriate impact assessment framework would facilitate the systematic evaluation of the results and conclusions.

Marine Traffic and Ship Strikes

Project Application: Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations

Marine mammals are identified as an Environmental and Socio-economic element occurring in the Marine RSA and the Proponent describes effects of the Project on marine mammals in section 4.3.13 as "Accidents and Malfunctions"; and in section 4.3.7.4 *(Potential Effects and Mitigation Measures)* as a result of normal operations. The Proponent considers ship strikes to be an accidental event based on shipping statistics for the Marine RSA drawn from a TERMPOL

report (Moffat and Nichol 2013; referenced in list of documents above) and DFO's Marine Mammal Incident Database regarding numbers of reported of ship strikes on whales. Specifically, the Proponent characterizes ship strikes in section 4.3.13 (Accidents and Malfunctions) as:

> *"unplanned events that could result in significant adverse effects to ...the environment; however, are unlikely to occur... accidents and malfunctions are predicted to be unlikely for the increased Project-related marine vessel traffic...."*

And, in section 4.3.13.5.4 *Physical Injury or Mortality of a Marine Mammal Due to a Vessel Strike* states:

> *"While ship strikes leading to marine mammal fatalities can and do occur, such occurrences are infrequent relative to the number of vessels (of all sizes and classes) on the water";*

and

> *"The overall probability of a Project-related vessel striking and injuring a marine mammal is considered low"; and "the frequency of [injury or mortality of a Marine Mammal to a Vessel Strike] is considered accidental and rare for any particular vessel".*

The information and analysis provided is insufficient for either a quantitative or a qualitative evaluation of the current rate of ship strikes, or how the rate may increase with the proposed increase in vessel traffic. Neither the analysis of shipping statistics for the Marine RSA, nor analysis of the data from the DFO's Marine Mammal Incident Database, is used in a manner suitable for assessing the potential effect (exposure or consequence) of ship strike events on marine mammals in the Marine RSA. Specifically:

- Ship strikes are known to occur under normal shipping operations. However in many cases ship operators are unaware that a ship strike has taken place, and struck whales are often either not detected and/or sink. As a result, statistics based on recovery of dead whales under-represent the true frequency of ship strikes (Laist *et al.* 2001; Douglas *et al.* 2008). Therefore, ship strike data in DFO's Marine Mammal Incident Database do not represent the true frequency of ship strike occurrences. This uncertainty has not been taken into account.
- No information is provided about speed or maneuverability of Project-related ships, distribution of whales in relation to the shipping lanes, or shipping intensity in the Marine RSA.

To evaluate the effect of potential ship strikes, related to the Project, on marine mammals, a risk assessment framework that considers the likelihood of a vessel strike to an individual of a specific cetacean population, the size and status of that particular cetacean population, and the propensity of that population for being struck by ships is necessary, but has not been completed. For example, for cetacean species listed as Threatened or Endangered under Canada's Species at Risk Act, such an assessment would consider the risk of injury or mortality of an individual as a potential threat to the viability of already small populations (Williams and O'Hara 2009). Without such a structured qualitative/quantitative framework, the assessment is insufficient to evaluate the conclusion that the probability of a Project-related vessel striking and injuring a marine mammal is low, or that the occurrence of injury or mortality of a marine mammal would be infrequent.

It should also be noted that because there is evidence that ship strikes are known to occur under normal shipping operations, ship strikes could be considered a collateral effect of routine marine shipping, and be treated similarly to disturbance or injury from underwater noise.

Marine Traffic and Underwater Noise

Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations subsection 4.3.7.4.2. The Project Application includes a qualitative assessment of "significance" of the potential effect of underwater noise on each of the marine mammal indicator species, as summarized in Tables 4.3.7.9 1(a) and 2(a). The Proponent does not present a quantitative or qualitative framework by which to measure or classify the effect or consequences of the noise. However, the Proponent refers to a study that identifies sound levels that were correlated with specific behavioural changes in Northern Resident Killer Whales (MacGillivray *et al.* 2012), but does not formally include these data to evaluate Project-related underwater noise and potential impacts on Southern Resident Killer Whales. From MacGillivray *et al.* 2012:

> *"The study determined that at received sound levels of approximately 64 dB re: HT [Hearing Threshold], killer whales overtly avoided a whale-watching boat, while at received SPLs of approximately 57 dB re: HT, they exhibited subtle avoidance responses."*

While this study is identified, the Proponent does not formally incorporate the data from the study or acknowledge that there may be a link between the observed behavioural responses of Northern Resident Killer Whales at these sound levels, and the probability of behavioural responses of Southern Resident Killer Whales at the noise levels that are anticipated as a result of increased Project-related vessel traffic. DFO recognizes that quantifying the effects of individual behavioural response at the population level is difficult. However; there have been important advances in this area that highlight the evidence of physiological responses to increased noise at below threshold levels (Rolland *et al.* 2012). As well there are recent efforts to develop frameworks to relate noise disturbance to individuals to population level effects (Clark *et al.* 2009; NRC 2005). Noise impacts on reproductive success and survival are pathways to a population level effect, but these have not been formally considered by the Proponent.

Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations, Table 4.3.7.9. The Proponents provide a definition of significance that does not incorporate information or data to allow for a quantitative assessment to determine under what conditions "significant" noise events occur. The Project Application states that significance means:

> *"A high probability of occurrence or a permanent or long-term residual effect of high magnitude that cannot be technically or economically mitigated".*

The effects assessment incorporates information from SARA Recovery Strategies and Management Plans and COSEWIC reports for the indicator species (Southern Resident Killer Whales, Humpback Whales, Steller Sea Lions). The effect assessment considers the following information:

- whether or not underwater noise is listed as a threat or concern for the species
- the length of time an individual might be exposed to noise from a single Project-related ship in the RSA
- whether all or only a portion of the species population occurs in the RSA
- the proportion of the year that the population resides in the RSA
- whether or not Critical Habitat for the species overlaps the RSA
- whether or not the acoustic environment is identified as a feature of Critical Habitat for the species

While the use of this information may be appropriate, it is not presented in a qualitative framework that illustrates how these factors were ranked. As presented in Table 4.3.7.9, it is not possible to evaluate the Proponent's conclusion that the residual effects would be significant for Southern Resident Killer Whales, but not significant for either Humpback Whales or Steller Sea Lions.

Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations, subsection, 4.3.7.4.5, *Assessment of Potential for Residual Effects of Auditory Injury*
Potential harm from Project-related marine vessels has been assessed quantitatively by comparing the modelled sound level contours against published acoustic thresholds associated with temporary and permanent hearing threshold shifts (TTS and PTS). The assessment of effects from noise levels at or below the threshold for behavioural disturbance is not sufficient. The assessment considers noise from a single Project-related ship, without taking into account the additive and cumulative effects of existing noise, or increased noise due to Project-related increases in vessel traffic. These omissions inhibit the assessment for potential residual effects from Project-related ship noise on indicator marine mammal species. The limitations in the application of the model will be addressed in the next section.

Model Adequacy and Applicability: Are the methods used to assess the potential effects of underwater noise and marine vessel strikes on the marine mammal indicator species appropriate and executed properly?

Ship Strikes

While the potential for marine mammal-vessel ship strikes is discussed in the Project Application, the potential risks associated with ship strikes and marine mammals have not been quantified or formally assessed using any existing methodologies (e.g., Vanderlaan *et al.* 2008; Williams and O'Hara 2010). In general, methods to assess potential effects and likelihood of ship strikes to marine mammals in the Marine RSA are lacking.

Underwater Noise

JASCO's Marine Operations Noise Model (MONM), used to determine noise sound fields radiating from transiting tankers and escorts, is a state of the art model that incorporates important parameters related to acoustic propagation characteristics in the Marine RSA. Sound levels at various distances from a modelled ship are considered relative to existing acoustic thresholds reported as sound pressure or exposure levels in decibels (dB) associated with auditory injury (Temporary Hearing Threshold Shifts TTS, and Permanent Hearing Threshold Shifts PTS) as well as an acoustic threshold believed to be associated with behavioural disturbance (Southall *et al.* 2007; NOAA 2013). The resulting outputs are measures of the distance, in kilometres, from the ship at which noise above these thresholds would occur. This review, however, finds that the model has not been applied in a manner that fully assesses ship noise in the Marine RSA.

Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations, subsection 4.3.7.4.4 *Summary of Acoustic Modelling Results* presents four different scenarios with Aframax tankers at different speeds and with different tug escorts. The resulting radii of underwater sound pressure level contours are presented in Table 4.3.7.3. Areas that are known to be within critical habitat for the indicator marine mammals species, for example, the Boundary Pass region, a known area of frequent transit by Southern Resident Killer Whales, have not been included in the four modelling locations. The oceanographic conditions in the Boundary Pass region may vary significantly from the conditions in Haro Strait (Hauser *et al.* 2007). To adequately assess the exposure of marine mammals to underwater noise, the model should have been run along the whole ship-track, with a realistic combination of tanker

speed and tug escort. With this configuration, a map could have been generated to show the radii of underwater sound pressure level contours along the complete ship track through the Marine RSA, from which the spatial and temporal overlap with known distributions of indicator species could be determined.

Data used in the MONM may not be adequate to characterize the acoustic propagation properties of the Marine RSA. In the description of MONM, it is stated that the sound speed profiles used in the modeling come from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM), with monthly profiles in latitude/longitude grid with 0.25° resolution, which translates to approximately 15 nm between grid points. It is not clear how well these data represent the sound speed profiles in tidally controlled areas like Haro Strait and Boundary Pass. More appropriate data from these areas are available in DFO's archives. The modeling should also be conducted for typical winter and summer conditions to allow for evaluation of seasonal differences in sound propagation characteristics, and to determine whether certain locations need further attention, especially if they are known to be visited frequently by marine mammals.

Volume 8A, Marine Transportation, section 4.3 Effects Assessment – Marine Vessel Traffic operations, subsection, 4.3.7.4.5, *Assessment of Potential for Residual Effects of Auditory Injury*
The assessment of potential harm from the additional shipping activity is primarily focused on the more serious, but less likely, temporary and permanent threshold shifts (TTS and PTS) that could occur in marine mammals exposed to transiting ships. Based on results from the MONM the Proponent concludes that noise-induced temporary threshold shifts and permanent threshold shifts from the increased Project-related shipping are unlikely because noise at such levels would only occur quite close to the ships. However effects from chronic exposure to noise levels that are below the TTS threshold level is a significant concern in the Marine RSA, particularly for SARA listed cetaceans (Erbe *et al.* 2012; Williams *et al.* 2013; DFO, 2011).

The underwater noise environment in the Marine RSA is not adequately modelled in the Project Application; only Project-related ship noise is modeled, and not the additive and cumulative effects of existing ship source noise. The model is currently used only to assess the impact of a single Project-related ship passing a single stationary marine mammal. As the number of ships transiting the area from all sources increases, the frequency and duration of relative quiet will decrease correspondingly. Model outputs that include additive and cumulative effects of Project-related and existing ship noise would be a more accurate measure of the noise environment to which the marine mammals would be exposed.

Conclusions

There are deficiencies in both the assessment of potential effects resulting from ships strikes and exposure to underwater noise in the Trans Mountain Expansion Project Application documents.

There is insufficient information and analysis provided with which to assess ship strike risk in the Marine RSA from either existing or Project-related traffic. Ship strike is a threat of conservation concern, particularly for baleen whales such as Fin Whales, Humpback Whales and other baleen whales (Gregr *et al.* 2006). If shipping intensity increases as projected in Section 4.4 in the Marine RSA and the Strait of Georgia and Juan de Fuca Strait as a whole, the significance of this threat to cetacean populations that occupy the region will increase.

Incidence of recovered whale carcasses is not considered to be an adequate measure of the frequency of ship strikes. No information is provided about the speed and maneuverability of Project-related ships or the distribution of whales in relation to the shipping lanes. Analyses that

consider the statistical probability of ship-whale encounters and the risk of collisions are considered appropriate methodologies to assess this potential effect.

The JASCO MONM model, as it has been applied by the Proponent, is not adequate to assess the overall impact of noise from increased Project-related traffic. Although state-of-the-art acoustic modelling has been used to model the noise propagation associated with a single Project-related tanker in the Marine RSA, only four locations were chosen to represent the Marine RSA; therefore, the assessment does not adequately represent the noise exposure for the entire time a marine mammal would be in the RSA. The assessment represents only Project-related tanker traffic and not the current noise environment or the potential increase due to Project-related traffic. Finally, the method used to assess the significance of impacts from the modelled noise level contours resulting from a single Project-related tanker and tug on indicator cetacean and pinniped species is qualitative and the lack of an appropriate assessment framework reduces DFO's ability to evaluate the assessment.

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